CHAPTER 24

Musical potential

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Introduction

There is general agreement that music is a universal trait of humankind (Blacking 1995), that *Homo sapiens* as a species has the propensity for musical development, and that musical potential is as universal as linguistic ability (Wallin *et al.* 2000). An ongoing controversy persists however, concerning the extent of individual variability in musical potential and the extent to which observable differences in acquiring musical skills result from social contexts that facilitate learning, genetic factors, or interactions between the two. This chapter outlines key elements of these debates and also considers how 'musical potential' has been assessed.

The nature–nurture debate

Francis Galton (1876) pioneered the study of genetic influences on learning and development using evidence from twin studies to argue that traits leading to eminence were largely inherited. However, recent research suggests that there are complex interactions between the environment and genetic factors which influence observable behaviour, with genetic factors having a closer association with physical attributes than psychological factors, and that many dimensions of an individual's development, such as memory, language development and intelligence, can be enhanced through systematic practice and learning (Gross 2005). Research attempting to establish the extent of the heritability of musical potential has reached similar conclusions with no decisive evidence showing that it is directly dependent on aural acuity, intelligence, or other types of artistic ability (for reviews see Hodges 1996; Shuter-Dyson 1999). A more plausible explanation is that musical development is the result of a range of gene combinations interacting with environmental stimulation in an interactive rather than additive manner (Ceci 1990). Evidence that the cerebral cortex has an amazing ability to self-organize in response to stimuli such as music supports this view (Rauschecker 2003). Cortical activation during music processing reflects personal musical experiences accumulated over time including listening to music, learning to play an instrument, formal instruction, and professional training resulting in multiple mental representations of music that are, in part, interchangeable and rapidly adaptive (Altenmuller 2003). While self-selection for musicianship by individuals with innate functional and structural brain differences cannot be completely ruled out, the evidence indicates that it is musical training that leads to changes in brain function and structure (Schlaug 2003). As genetic inheritance can clearly be enhanced by a musically enriched social context, considerable research is now focused on identifying the environmental factors that facilitate or impede musical development.

Musical savants and Williams syndrome

The most difficult phenomena to explain without resorting to some notion of inherited differences in musical potential are children at the extremes of neurodevelopment, for instance, musical savants, children with Williams syndrome, and child prodigies.

Savants have generally low cognitive functioning but are able to achieve at normal levels in some activities, especially those related to 'non-symbolic, artistic, visual and motor abilities' such as 'music, art, maths and various forms of calculating (such as calendar-counting)' (Gross 2005, p. 685). Many musical savants exhibit absolute pitch (Miller 1989) enabling them to make confident, rapid judgements about individual pitches and complex chords. They are also sensitive to rules reflecting harmonic relationships and the structure of musical compositions (Young and Nettelback 1995; Sloboda *et al.* 1985). Explaining these skills without resorting to genetic explanations is difficult. However, environmental influences should not be underestimated. Many savants have limited sight and language disorders, which may lead to increased development of auditory processing skills and the use of music as a means of communication. They also spend considerable time practising their skills.

Individuals with Williams syndrome have low measured intelligence and difficulties with mathematical and spatial reasoning but are more adept than might be expected in language and music, the development of the latter depending on access to appropriate musical opportunities. Levitin and colleagues (Levitin and Bellugi 1998; Levitin *et al.* 2003, 2007) have shown that these children are typically as musically accomplished, engaged and interested as ordinary children but display greater emotional responses to music, become interested at a younger age, spend more time listening to music, instinctively experience music much more fully than others, and possess a highly sensitive emotional attachment to music.

Musical prodigies

Prodigies are children who, from an early age, display exceptional talent. Famous examples include Mozart, Bach, Beethoven and Mendelssohn whose significant success in later life depended on having undertaken considerable focused and well-directed effort during their early years (McPherson and Williamon 2006). Ruthsatz and Detterman (2003) identified a recent example of a prodigy, a 6-year-old who despite having had no formal tuition acquired considerable musical skill by imitating other performers and improvising his own musical pieces. He could sing in two languages, had taught himself to play numerous instruments, had an Intelligence Quotient (IQ) of 132, an extraordinary memory, and attained a high score on Gordon's (1982) music aptitude measure. His exceptional musical behaviours were self-motivated and spontaneous and he particularly liked entertaining people. His musical abilities were closely aligned with his extraordinary memory and high IQ, more so than with the time or type of practice he undertook. As we will see below, such early, specific situational behaviours that spark changes in cognitive development to allow a child to be able to direct extremely high levels of attention toward music are becoming of great interest to researchers.

The overt musical behaviours of savants and Williams syndrome individuals share some similarities with the behaviour of prodigies, even though their neurodevelopmental trajectories differ. Neuroconstructivists suggest that typical and atypical development can be viewed as different trajectories in a continuum of possibilities. An atypically developing trajectory affects the interactions of others with the child and the kind of experiences that the child seeks out, which further impact on the trajectory (Mareschal *et al.* 2007). For example, when parents believe that their child has musical ability, they are more inclined to provide musical resources and reward musical activity, which in turn supports increasing levels of expertise as the child engages more fully with music (McPherson, in press). These social dynamics result in the child developing particular neural structures that make further musical development much easier (Altenmüller and Gruhn 2002; Hodges 2006). Familial responses of this type may occur in relation to savants, Williams syndrome children, and prodigies.

Other research suggests that the typical 'rage to master' which characterizes prodigies can be explained as a result of domain-specific high attentional control that begins in infancy to produce a spontaneous version of deliberate practice (Vandervert and Liu in press). This view suggests that the high attentional control of prodigies originates and then accelerates connections between the cerebral cortex (where mental modelling construction and repetition occur) and the cerebellum (where model formation occurs), such that cerebellar control models feedback to the working memory areas of the cortex. In this way the child prodigy's working memory becomes faster, more concentrated, and more efficient (Vandervert 2007). This explains the behaviour of these individuals in terms of 'the *reciprocal* learning relationships between the anticipatory, *adaptive* cognitive-affective and attentional modelling functions of the cerebellum and those of the cerebal cortex' (Vandervert and Liu in press).

Shavinina (in press) proposes that extreme levels of giftedness occur as a result of stimulation and activation early in life when the developing child selectively responds in ways that heighten his or her cognitive, emotional, and social sensitivities. Such sensitive periods in these children's early years provide the foundations for giftedness in that they accelerate the gifted child's mental development through the actualization of intellectual potential and cognitive experience (Shavinana 2007). Cognitive experience of this type provides the psychological basis from which highly gifted children are able to develop their creative, metacognitive, and extracognitive (i.e., feelings, beliefs, intellectual values, intuition) abilities.

The above explanations support an interactive, dynamic model of how exceptional achievement in music develops as a result of environmental forces acting together with innate potentials at critical moments in a child's development. The following sections attempt to frame these conceptions within specific areas of musical engagement.

The role of learning in the development of musical expertise

Research undertaken within the expertise paradigm has also challenged previously accepted notions that high-level achievement depends exclusively on inherited ability. The basic premise of this theory is that time spent on 'deliberate practice' underpins the development of high-quality expert performance. For instance, it has been established that classical Western musicians need to have accrued up to 16 years of practice to achieve levels that will lead to international standing in playing an instrument. Such individuals usually begin playing at a very early age and over succeeding years increase the amount of practice undertaken, sometimes up to as much as 50 hours a week by adolescence (Sosniak 1985).

Ericsson and colleagues (1993) have suggested a monotonic relationship between 'deliberate practice' (which they define as goal-oriented, structured and effortful practice that is influenced by motivation, resources and attention) and an individual's acquired performance (for review see Chapter 25 this volume, Lehmann and Gruber 2006). This is supported by evidence that musicians with the highest levels of expertise accumulate considerably more hours of practice than their less successful peers, although there are substantial individual (Jørgensen 2002; Sloboda *et al.* 1996), instrumental and genre differences (Kopiez 1998; Gruber *et al.* 2004; Jørgensen 2002).

While researchers agree that practice is important in facilitating the development of expertise, several studies question the simplicity of a monotonic relationship. Sloboda and Howe (1991) found that students identified as having greater ability by their teachers had spread their practice across each of their instruments and therefore undertaken less practice on their main instrument. Wagner (1975) found that increased practice did not lead to any greater improvement in performance over an eight-week period, and Zurcher (1972) found no relationship between total practice time and performance achievement.

Reported correlations between achievement and time spent practising vary between 0.25 (Doan 1973 and 0.67 (Hallam 1998a). In the Hallam study, the correlation rose to 0.84 when years of time learning was correlated with achievement, as opposed to time spent practising. It seems therefore, that the overall length of time over which learning has taken place may be as important as the actual amount of practice in determining level of expertise. This was especially evident in a causal model developed by McPherson *et al.* (1997) which shows a strong association between the length of time learning and taking lessons and high school musicians' ability to sight-read and perform music that they had rehearsed over the previous weeks and months.

Accumulated practice from the time of beginning learning to the present does not seem to predict the quality of performance at any point in time (Hallam 1998a; Williamon and Valentine 2000). Other factors such as teachers' ratings of musical ability, self-esteem, and involvement in extra-curricular music activities are better predictors of achievement (Hallam 2004). A longitudinal study with beginning instrumentalists also showed that accumulated practice only partly explains children's ability to perform rehearsed music and sight-read and none of their ability to memorize music, play by ear, or improvise. McPherson (2005) showed that accumulated practice explained between 9 and 32 per cent of the variance in the learner's ability to perform rehearsed repertoire over their first three years of learning, and even less for their sight-reading ability. Other skills, such as the sophistication of the mental strategies which the young players adopted to guide their playing, were more important (see also Chapter 25 this volume).

To date, much of the research has failed to take account of the amount of time spent acquiring musical skills through listening to music, engaging in playful musical activity, and participating in group activities where learning and consolidation of skills occurs in an informal learning context (e.g. Kokotsaki and Hallam 2007). In addition, research has neglected those who may have undertaken considerable amounts of practice but have dropped out of music instruction. There are complex relationships between prior knowledge, motivation, effort and perceived efficacy which influence decisions to continue or discontinue learning (Hallam 1998a; Sloboda *et al.* 1996). When a child begins to learn an instrument, prior musical knowledge affects facility of learning and the time needed to achieve mastery. While undertaking additional practice may compensate for a lack of prior knowledge, this has a time cost and requires perseverance. If a task proves too challenging, then a child may perceive that the effort required to succeed is too great and may give up learning altogether (Hurley 1995). Difficulties may also be evident when a child perceives that he or she does not have sufficient ability. Such perceptions often lead to a loss of self-esteem, loss of motivation, less practice, and a downward spiral leading to the termination of lessons (Austin *et al.* 2006; Chandler *et al.* 1987).

Another way to understanding individual differences is to focus on the personal beliefs held by learners and their parents. Parental and child ability conceptions are recognized as having a major impact on motivation and the desire of children to continue learning, especially when faced with obstacles (Austin *et al.* 2006). Indeed, McPherson's (in press) review of literature on mother–child interactions shows that parental ability conceptions can be self-fulfilling. McPherson and Davidson (2002) interviewed mothers before and after their child commenced learning an instrument. Those who held fixed views that their child may not have sufficient ability to succeed musically tended to provide less support for practice than mothers whose view was more malleable. They were also more likely to encourage their child to pursue other activities when they came to believe that their child was not coping. These fixed views of musical potential explained why some of the unsuccessful learners came to feel that they did not have sufficient ability to cope with learning music. Some mothers actually gave up on their child as a potential musician much sooner than the child.

The development of general musical skills

The impact of parents and the home environment is of profound importance in the development of children's musical potential (McPherson, in press). The general milieu of the environment to which a child is exposed and the opportunities parents and significant others provide are among the most critical factors for realizing children's musical potential (McPherson and Williamon 2006)(see also Chapter 28 this volume).

The seeds of musical potential are sown early because the human auditory system is functional 3–4 months before birth. After 28 to 30 weeks of gestation, foetuses can reliably react to external sounds, such that their heart rates vary as a result of exposure to music (Parncutt 2006). The process of musical enculturation therefore begins from the point at which brain development starts to become influenced by auditory stimulation. These processes gain momentum in the minutes after birth when a mother and infant will imitate each other's vocalizations in ways that show a shared emotional experience that some believe is the very basis of musicality (Trevarthen and Malloch 2002).

In the immediate months after an infant is born, the complex skills required for understanding and analysing music within any particular culture start to develop as a result of ongoing exposure to music. Even though each infant will experience many different levels of exposure, the perceptual and motor control needed to sing an intended pitch and the self-monitoring necessary to notice pitch or rhythmic differences can be accelerated by training (Trehub 2006). Wide individual differences exist regarding the extent to which preschool children engage in singing. For some, it is a part of almost all activities, while others sing only occasionally (Sundin 1997). Even though their exposure to music will have been markedly different, all children will have typically developed a surprising array of internal schemata for particular types of music long before they reach school or begin formal music instruction.

Measuring musical potential

Historically, the developers of musical aptitude tests have held varying views regarding the heritability of musical ability. Seashore (1938a, Seashore *et al.* 1938) believed that musical ability was a set of loosely related basic aural discrimination skills, which had a genetic basis and did not change over time. Wing (1981), Drake (1957) and Bentley (1966) shared Seashore's view of musical ability as being inherited, although they differed in their conceptions of the nature of that ability and how it might be assessed.

More recent tests, based on measurements involving tonal (melody, harmony), rhythm (tempo, metre), and preference (phrasing, balance, style) aptitudes, have been devised by Gordon (1965, 1979, 1982). Gordon (2007) suggests that students rarely display high (or low) aptitudes in all seven aptitudes and that all are based on the ability to 'audiate'; a term he has coined to describe how individuals give meaning to music that is heard or imagined.

The rationale underlying all of these approaches is that 'musicality' has its basis in aural perception. However, the predictive reliability of all of these measures is generally low (Hodges and Haack 1996). While alternative, more active measures for selecting pupils for learning to play an instrument have been adopted by teachers, these have tended not to be formalized. Perhaps the most common of these has been selection based on the child's ability to sing. However, the relationship between developmental tonal aptitude and use of the singing voice may also be very small (Rutkowski 1996). Researchers now generally recognize that aural skills alone are insufficient to predict future success across the full range of musical activities, especially those involving motor skills (Gilbert 1981) and creativity (Vaughan 1977; Webster 1988).

Recent conceptions of musical potential

McPherson and Williamon (2006) adapted Gagné's (2003) *differentiated model of giftedness and talent* to music as a means of defining the natural innate abilities, intrapersonal factors, and environmental catalysts that might impact on the development of musical skills. This conception defines *gifts* (e.g., intellectual, creative, socio-affective, sensorimotor) as natural innate potentials to achieve and *talent* as observable skills. The framework proposes that at least eight distinct types of musical talents (performing, improvising, composing, arranging, analysing, appraising, conducting, music teaching) can be developed through systematic practice and training. Moreover, although physical and mental dexterity, musicality, motor memory and auditory memory are all evident in the first few weeks of formal musical training, each needs to be refined and developed further through extensive practice and learning for children to develop their musical talents. Another key element of the theory is that some types of talents can go unnoticed or, as in the case of composing, develop later than others. By including a range of non-performance based outcomes of musical involvement, the model represents a broader conception of musical potential than has been evident in the past.

As an extension, McPherson (1993, 1996) distinguishes between visual (i.e., sight-reading, performing rehearsed music from notation), aural (i.e., playing from memory and by ear) and creative (i.e., improvising) aspects of music performance. When considering these in relation to groups of children of differing ages and abilities, he found that different musical skills are involved in developing each of these ways of performing music, that there is not an automatic transfer between the three orientations, and that each needs to be developed separately and in combination to maximize potential. This is rarely the case in most formal learning situations, where visual forms of performance often dominate at the expense of other orientations.

From an even wider perspective, Hallam (1998b) suggests that learning to play a musical instrument depends on the development of a wide range of different professional and personal skills. Some of these may be required for all musical activities, and others are applied more selectively to particular tasks (see Table 24.1). In order to become a successful musician, individuals need to develop social skills (being able to work with other musicians, promoters, the public); planning and organizational skills (planning practice schedules, programmes, travel

Table 24.1 Musical skills

Aural skills required for:	Developing rhythmic accuracy and a sense of pulse;
	Good intonation;
	The facility to know how music will sound without having to play it;
	Improvisational skills.
Cognitive skills required in the processes of:	Reading music;
	Transposition;
	Understanding keys;
	Understanding harmony;
	Understanding the structure of music;
	The memorization of music;
	Composing;
	Understanding different musical styles and their cultural and historic contexts.
Technical skills required for developing:	Instrument specific skills;
	Technical agility;
	Articulation;
	Expressive tone quality.
Musicianship skills are concerned with:	Being able to play expressively;
	Being able to project sound;
	Developing control;
	Conveying meaning.
Performance skills include:	Being able to communicate with an audience;
	Communicating with other performers;
	Being able to coordinate a group;
	Presenting to an audience.
Learning skills are concerned with:	Being able to learn, monitor and evaluate progress independently.

arrangements); and time management skills (being punctual, meeting deadlines). These are clearly required for developing expertise in a range of professions and while necessary are not exclusively 'musical'.

Actualization of musical potential

In the modern world, children have greater access to music through the media and are able to learn music in a multitude of different ways from the past. Technological developments have resulted in changes to the way music is perceived and valued within society, such that mere aural perception is no longer regarded as the defining aspect of musical ability.

Haroutounian (2000), in analysing the level of importance attached to particular criteria in identifying musically able children, suggests that the general behaviours of 'sustained interest' and 'self-discipline' are more important than music-specific characteristics which are normally regarded as indicative of musical ability. Similarly, Hallam and Prince (2003) asked a sample of musicians, student musicians, educators, and the general public to define musical ability. They reported that 71 per cent of the respondents viewed musical ability as being able to play a musical instrument or sing. This finding suggests that musical ability is often identified on the basis of developing practical skills. Overall, 28 per cent of the sample mentioned aural skills as indicative of musical ability, 32 per cent included listening and understanding, 24 per cent having an appreciation of music, and 15 per cent being responsive to music. The integration of a range of skills was cited by only 9 per cent of respondents. Personal qualities including motivation, personal expression, immersion in music, total commitment, and metacognition (being able to learn how to learn) were cited most often by musicians. Unsurprisingly, the musicians gave more complex responses, with many more elements in their explanations.

Further work by Hallam and Shaw (2003) using rating scales to illicit responses to a set of statements about musical ability showed that it was conceptualized in relation to rhythmic ability, organization of sound, communication, motivation, personal characteristics, the integration of a range of complex skills, and performing in a group. Having a musical ear ranked lower in responses than might have been expected given its prominent position with regard to musical ability historically. The high ratings given to motivation and personal commitment demonstrate their importance in developing high-level skills. Overall, the conceptions of musical ability generated by the research were complex and multifaceted, and they reflected the wide range of expert achievement that occurs in the music professions of the developed world.

Conclusions

The extent to which genetic endowment underpins or limits all subsequent musical development has and continues to be fiercely debated (see Hallam 2006; McPherson and Williamon 2006; *High Ability Studies* Volume 18; *Behavioral and Brain Sciences* Volume 21), although there is general consensus that human beings as a species are pre-programmed to acquire a wide range of musical skills. We argue that what children are born with *enables* rather than *constrains* what they will eventually be able to achieve. While a range of generalized abilities may come into play when learning music, a host of environmental and personal catalysts work in combination with teaching and learning processes to develop particular types of talent. These talents form the basis of the many varied ongoing professional, amateur, and informal forms of meaningful engagement that individuals can have with music.

In developed countries, where formal schooling has taken over some of the traditional roles of the family, tests of musical aptitude have been devised to facilitate the identification of children who might benefit from music instruction, or to provide a base line for catering for individual differences after instruction has commenced. In our view, the rationale that underpins approaches based exclusively on aural acuity is questionable, especially given current methodologies and technologies which do not enable us to state with any certainty whether observed differences in musical ability in children are the result of genetic inheritance or learning.

As noted by Kemp and Mills (2002), musical potential is a complex phenomenon that involves many factors. While aural abilities are undeniably important, they do not provide the basis from which to accurately assess a child's current or future musical potential. Instead, musical potential is best thought of as malleable and ever-changing, and a dimension of human experience that takes many forms and occurs at many different levels. As a species-specific behaviour, music is inextricably linked to our basic human design (Welch and Adams 2003), therefore all children are inherently musical and deserve access to the types of informal and formal experiences that will maximize their own, individual musical potential.

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